Local action plan for the port of Dubrovnik

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Introduction

Local action plan for the port Dubrovnik is developed based on D3.2.9 Territorial Needs Assessment (TNA) for the port of Dubrovnik. The goal of the action plan is to determine the actions which will lead to the reduction of carbon footprint of the port and make the port ready for future energy challenges. The action plan will identify the solutions which are already implemented and focus on short and longterm plans which will lead to a carbon neutral port.

Our increased mobility as a society does not come without a cost. As we have become more mobile, our carbon footprint has grown. This can be clearly seen from the chart presented by the European Environment Agency. According to the UNFCCC and EU Greenhouse Gas Monitoring Mechanism reports, the greenhouse gas emissions related to the transportation of goods and people have increased over the past three decades. In the same chart, the EEA presents the forecast for future greenhouse gas emissions in correlations with measures. It is clear from the chart that additional measures are needed to reduce the greenhouse gas emissions.

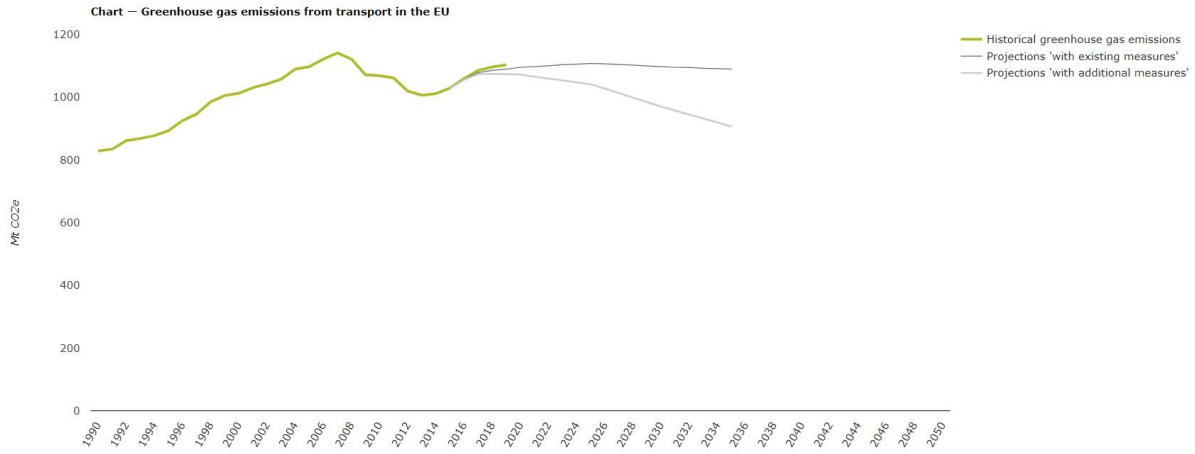

Figure 1. Greenhouse gas emissions from transport in the EU (European Environment Agency)

The European Green Deal has determined that by the year 2050, the EU needs to reduce the greenhouse emissions by 90%. Green ports will play a major role in EU's efforts to reduce the human impact on the climate and the environment. The diagram below shows the distribution of greenhouse gas emissions in the EU in 2017 by main source sectors. We can see that energy is responsible for 80.7% of greenhouse gas emissions in 2017, of which transport accounts for about a third.

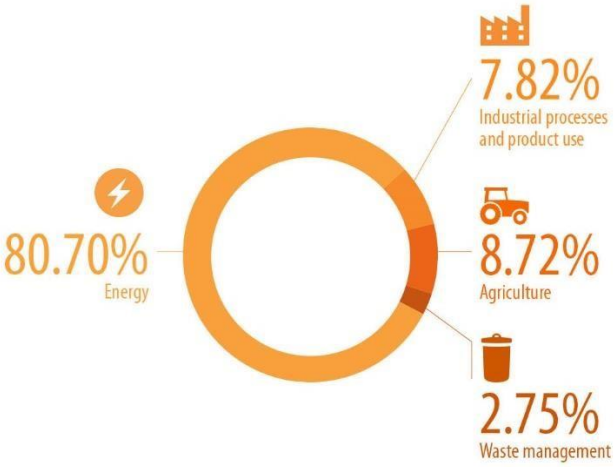

Figure 2. Greenhouse gas emissions in the EU by sector (United Nations Framework Convention on Climate Change)

Distribution of the greenhouse gas emissions related to different modes of transport indicates that road transports is still responsible for around 70% of the emissions. By 2030, 30 million cars in the EU will be zero emission and that will lead to the reduction of their impact on overall emissions. According to European Green Deal, another way to deal with the emissions related to road transportation is to shift transportation towards more sustainable transport like railways and waterways. Ports need to be ready for the increasing traffic and make traffic impact as low as possible.

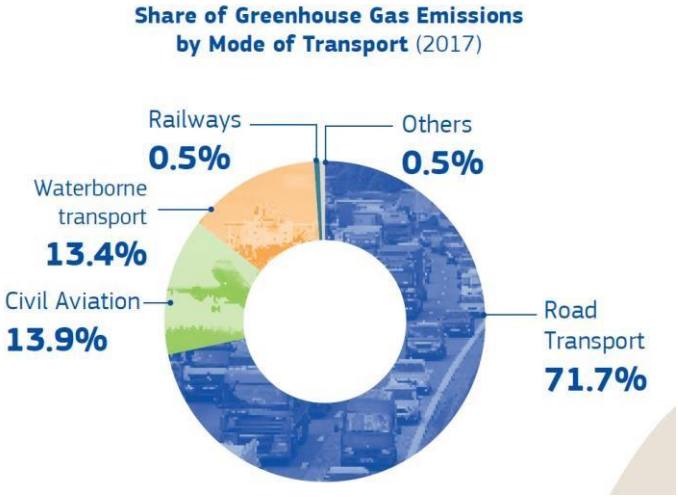

Figure 3. Share of Greenhouse Gas Emissions by Transport

Although ports are not a major source of GHG emissions when compared to total emissions in water transport, they can have a significant impact in terms of generated noise and pollution on a local level even now.

Port of Dubrovnik is looking to make sustainability between energy supply and demand. Local energy consumption can be covered by renewable energy sources. Additional energy required for vessels with shore connection will be achieved from the grid and it will be important to note the source of the energy. The port will continue to monitor and maintain (improve) high air quality and low level of noise in the port. This will lead to improving quality of life in the port area and the nearby surroundings.

SWOT analysis - weaknesses and threats

The biggest weakness of the port of Dubrovnik is the lack of space for the advanced infrastructure projects. Port of Dubrovnik is situated in the specific location surrounded by the city infrastructure and buildings, so it is a limiting factor when we speak about additional space needed for future development. Nevertheless, this can easily become an opportunity to make this area as efficient as it can be by developing projects using latest technology solutions.

The biggest threats to the environment are the cruise ships. The port of Dubrovnik receives the largest cruise ships (length > 200m) that produce the most pollution. When cruise ships are berthed, they produce the most of ports CO_2 footprint, due to their huge engine which remains active to maintain regular conditions for the crew and passengers. The second activity which produces the most CO_2 is mooring process. Nowadays, mooring includes long lines and requires huge human resources to successfully berth a ship. Automated mooring offers more than 90% reduction in emissions during mooring.

Actions for environmental sustainability and port energy efficiency

Following an integrated approach and considering current and future needs, PAD has undertaken the development of both infrastructural, organizational and management solutions that favour more efficient use of energy and resources.

Port area outdoor LED lighting

According to the Green Paper published by European Commission, lighting accounts for almost 20% of electricity consumption worldwide. Port of Dubrovnik still uses conventional lighting that consumes 80% more power than the new LED lighting systems. LED lighting is already a proven concept and some of its key advantages are:

- Higher efficiency
- Better control
- Durability
- Connectivity

Higher efficiency: energy savings accrued from the use of LED lighting go form 50% to up to 70%. These savings also have an impact on carbon emissions. It is expected that the price of LEDs will continue to decrease, and their efficiency will continue to increase.

Better control: with LEDs, we can dynamically control the light intensity and colour. Research shows that LEDs provide better visibility and pedestrians have better response to colour of the light. With the control of intensity, light pollution can be reduced.

Durability: the life span of LEDs is much longer than that of the conventional light systems. LEDs are expected to last around 50000 hours, which is around 50 times more than what can be achieved by the conventional light bulbs.

Connectivity: intelligent lighting system can provide us with noise detections systems, movement sensors, and real time air pollution monitors.

Overall power of installed outdoor lighting is 75,68 kW. These lights require around 310.288 kWh annually and represent huge impact on port financial budget. With the new LED lighting, which include replacing the lamps with conventional light bulbs like incandescent, fluorescent, halogen with LEDs, overall new installed power will be 36,62 kW. New system will require 150.137 kWh of energy annually which represent savings of around 51,6 %. CO_2 footprint is reduced by 52,85 t annually.

Renovation of the main office building

The environmental impact of buildings has become increasingly apparent. Many organizations recognize the value of green buildings and sustainability as part of their responsibility to more than just the bottom line. Green or sustainable practices within commercial buildings produce healthier and more resource-efficient models of operation and maintenance.

The Dubrovnik Port Authority building was built in 1978. In the Homeland War it was damaged by shells and fire, and in 1993 it was largely reconstructed. Replacement of openings, restoration of flat roofs and interior decoration were carried out. The upgrade of the building was carried out in 2000, when anex was upgraded on the ground floor in the northern part of the building. The building consists of the ground floor and two floors, with flat roof.

Energy renovation, in accordance with the project task of the investor, includes mechanical, electrical and partial construction measures.

Existing lighting is changing with new, more energy efficient, LED lighting.

The project task is planned to replace the existing heating system with a new water-to-water heat pump that would serve to heat/cool the offices of the first and second floor.

Construction measures refer to thermal insulation of ceilings above open space (S2), additional thermal insulation of roofs, and replacement of windows with energy-efficient aluminum profile windows with thermal bridge break and with three-layer glazing and lowE coating glass.

Activity	Current consumption [kWh/a]	New consumption [kWh/a]	Savings [kWh/y]	Savings [%]	CO2 savings [t/a]
New LED lighting	84.744	41.166	43.578	51%	14,3
New envelope and heating system	67.795	26.243	41.552	61%	9,4
TOTAL	**152.539**	**67.409**	**85.130**	**56%**	**23,7**

Table 1. Recap of the savings and CO2 emissions

Photovoltaic power plant for own consumption

Photo voltaic systems are one of the greenest and cheapest sources of electricity. Last year, the number of PV systems installed in the EU increased by 11%. EU plans to move from fossil fuels to cleaner and smarter energy. It is estimated that by 2040 20% of overall energy demand will be covered by PV systems. The port of Dubrovnik is in the south of Croatia and has excellent climate predispositions for installing photo voltaic energy systems (annual sum of global irradiation is 1564 kWh/m2). The port of Dubrovnik plans to install PV systems on roof areas and parking slots. The idea is to cover as much as possible electricity demands of the port through the PV systems.

Number of PV modules	1.187
PV modules covered surface [m^2]	2.000
Specific Annual Yield [kWh/god]	1.338,3 (smjer: jugozapad)
PV Generator Output [kWp]	373,91
Total Power [kW]	351

Table 2. Technical specification of PV system

The buildings in the port of Dubrovnik can be used as a place for roof mounted PV system and parking lot for parking cover PV system. According to the simulation, 1.187 modules can be mounted on 2.000 m^2 of area which will result in 373,91 kW_p of installed power. Installed PV system will produce 520.136 kWh annually, which means reduction of 122 tons of CO2 per year. The overall consumption of the port is 1.543.957 kWh annually and the PV system will cover 33,69% of the total yearly consumption.

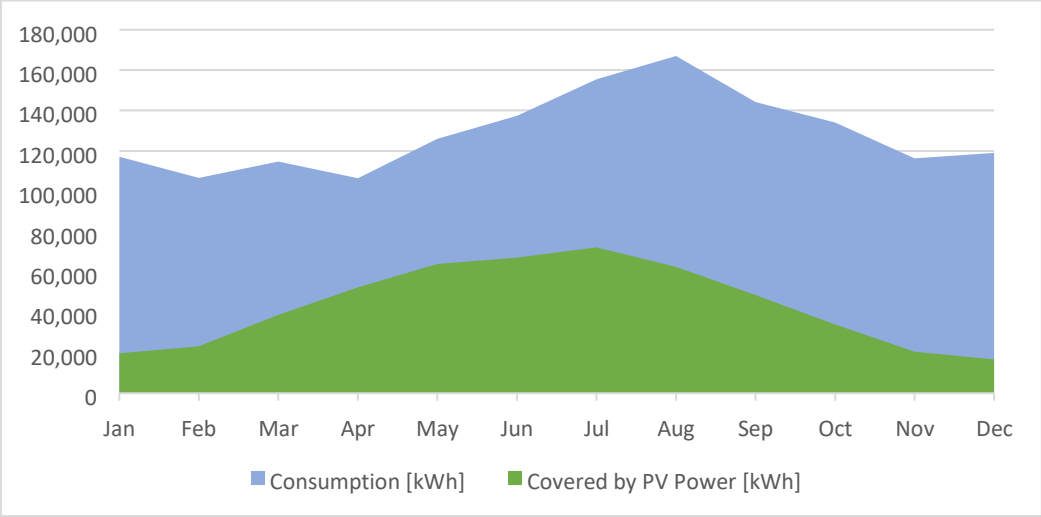

Figure 4. Share of PV production in overall consumption

It is not possible to use all produced energy from PV system directly on location, some of the energy will be transferred to grid. In this case 95,75% of energy will be spend directly on location while the rest will be feed to the grid.

HVSC (High voltage shore connection)

Shore Connection (long term) Shore Power Connection (SPC), Shore-To-Ship Power (SSP), Alternative Maritime Power (AMP) or Cold Ironing (CI), is the process of providing shoreside electrical power to a ship at berth while its main and auxiliary engines are turned off. The IEC/ISO/IEEE standard uses the term High Voltage Shore Connection (HVSC) systems.

High Voltage Shore Connection (HVSC) is one of the strategies recommended by several organizations to reduce the environmental impact of seagoing vessels in ports. HVSC replaces auxiliary engines at berth when berthed ships require electricity to support activities like loading, unloading, heating, lighting, and other onboard activities. Today, this power is generally provided by auxiliary engines that emit carbon dioxide (CO2) and air pollutants, affecting local air quality and ultimately the health of both port workers and nearby residents. The same holds for noise nuisance. As an alternative to onboard power generation, vessels can be hooked up to a shore power

connection, i.e., connected to the local electricity grid. In this way, ships' operations can proceed uninterrupted, while eliminating the negative side-effects.

HVSC is an emissions control measure that provides a connection to the local land-side power grid, rather than utilizing the ship's engines when at berth.

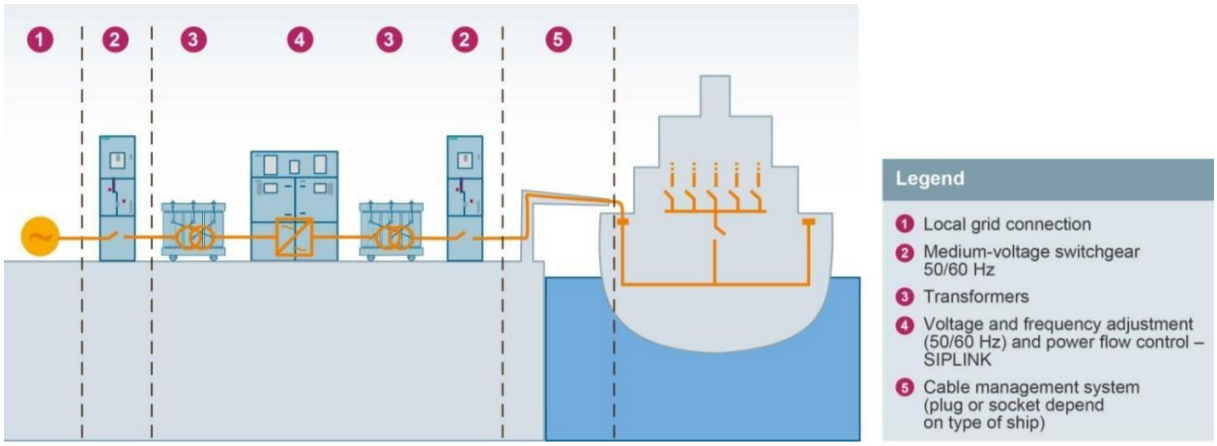

Figure 5. HVSC scheme

Figure 6. Quick and easy connection to the ship via the cable management system

Since cruise ships equipped with shore connection require huge amount of power (cruise ships above 200m require 12MW) usually additional electric power needs to be available at the port. Depending on the type of cruise ships that arrive at the port, the plan is to install at least one 15MW shore connection point in the first phase. Simply by "plugging in" to the city grid and turning off their engines, ships can reduce the annual CO2 emissions by up to 29%, with financial savings of up to 26% per call (case study port of Seattle). The average CO2 emissions from electricity production across the EU can be estimated as around 330 g/kWh. Emissions of CO2 for auxiliary diesel engines are on average around 690 to 720 g/kWh (Cooper, 2004). Therefore, on average, the use of shore-side electricity rather than electricity generation from diesel engines will reduce the CO2 emissions by more than 50%, according to the Service Contract on Ship Emissions by Commission Directorate General Environment document.

Average	CO2 (g/kWh)	*CO* (g/kWh)	CH4 (g/kWh)	N2O (g/kWh)
Electricity production (across EU)	295,73	0,0125	0,028	0,014
Auxiliary Diesel engines (AE)	720	1,3	0,01	0,031

Table 3. Emission per kWh

E-mobility car charging system

Since there is significant number of evidence that electric vehicles are more efficient than conventional ones, the port of Dubrovnik plans to install charging stations within and outside of port area. The plan is to install a three fast (11 kW) charging stations for the ports fleet. There is also a plan to install a rapid charging station (40kW) for passengers in transit, taxi services etc., since according to the European Green Deal, by 2025, about 1 million public recharging and refueling stations will be needed for the 13 million zero and low-emission vehicles. Also, e-bikes will be available within the port area, for shorter distances.

Electric vehicles consume average of 0.2 kWh/km and for same mileage they will require 18.500 kWh annually. CO2 generated for producing electricity in Croatia is 187.95 g/kWh and therefore overall CO2 annual emissions for electric vehicles are 3.459.000 g/kWh.

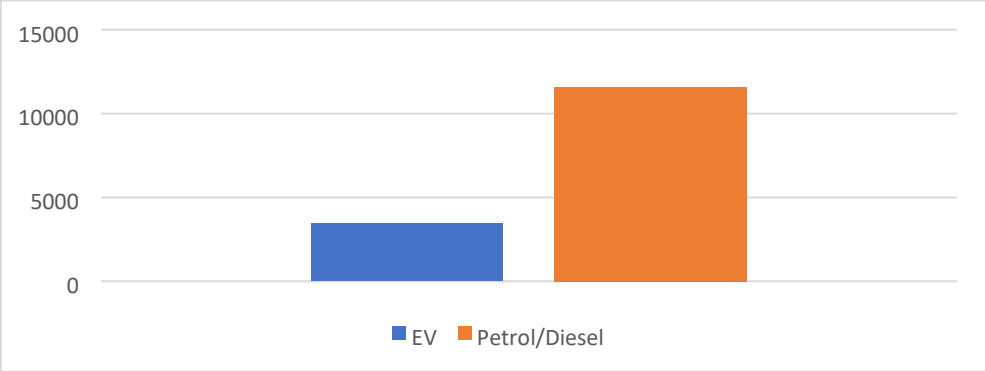

Figure 7. CO2 footprint based on annual milage

Replacing the car fleet with EV will lead to estimated savings of 8.122,75 t/CO2 annually or in the other words, more than 70 percent.

Automated mooring system

Mooring is a long process which requires a huge human potential and sometimes even the use of tugboats. Implementing the automated (vacuum) mooring system would reduce the mooring time by 20 to 90 minutes[1]. AMS will not only reduce mooring time but also lead to reduction of CO_2. From abstract of the study "Reduction of CO_2 emissions with automatic mooring systems. The case of the port of Santander" authors claim that compared to traditional mooring system AMS leads to reduction of more than 75% of CO_2. Another study "Effect on CO_2 emissions in maritime container terminals using new vessel mooring system by vacuum." have shown that ports with installed can expect the reduction of CO_2 emissions during mooring operations up to 98%.

[1] According to studies and data of the supplier

		CO2 emissions with ropes			CO2 emission with AMS			Reduction of CO2 emissions	
Port	Frequency	E ENTEC	E PA	AE ropes	E ENTEC	E PA	AE AMS	ENTEC [tons]	EPA [tons]
SALALAH, Oman	per day	21.7	26,4	24,1	0,4	0,4	0,4	21,3	26
	per week	162,8	198,1	180,5	2,7	3	3,3	160,1	194,8
	per month	651,3	792,5	722	10,9	13,2	12	640,4	779,3
	per year	7.815,30	9.509,70	8.662,50	130,3	158,5	144,4	7.685,10	9.351,20

Table 4. CO2 emission with different mooring methods

Key elements of mooring systems:

- mooring system can be operated by a single person with remote control
- risk of injuries is reduced to a minimum and tug usage can be improved and optimized
- improved utilisation of tug fleet:
- less wear and tear on fenders and ropes, • faster connection to shore power.
-

Figure 8. Automated mooring system in action

The port of Dubrovnik receives around of 400 cruise ships per year. It is estimated that it takes on average 30 minutes to berth the ship. With AMS, the port of Dubrovnik expects similar outcomes as other ports that implemented this system: significant reduction of CO2, up to 98%. Also, the emission of other pollutants (SO_2, PPM10) will be reduced while safety of personnel will be increased.

Time frame and possible sources of funding

Financing options, whether promoted at European, national, or regional level, are focused on the global strategic vision and EU directives marking the path to greener and sustainable future.

	Activity	2021		2022		2023		2024	
1	SUSPORT project								
2	PV project								
3	HVSC								
4	E-mobility								
5	Building refurbishment								

Table 5. Time frame for projects

Possible sources of funding

European Green Deal Investment Plan

On 11 December 2019, the European Commission (the "Commission") presented the European Green Deal (the "Green Deal"), with the aim that European Union becomes the first climate – neutral bloc in the world by 2050.

The European Green Deal Investment Plan (EGDIP), also referred to as Sustainable Europe Investment Plan (SEIP), is the investment pillar of the Green Deal. To achieve the goals set by the European Green Deal, the Plan will mobilise at least €1 trillion in sustainable investments over the next decade. Part of the plan, the Just Transition Mechanism, will be targeted to a fair and just

green transition. It will mobilise at least €100 billion in investments over the period 2021-2027 to support workers and citizens of the regions most impacted by the transition.

The European Green Deal Investment Plan has three main objectives:

- First, it will increase funding for the transition, and mobilise at least €1 trillion to support sustainable investments over the next decade through the EU budget and associated instruments, in particular InvestEU;
- Second, it will create an enabling framework for private investors and the public sector to facilitate sustainable investments;
- Third, it will provide support to public administrations and project promoters in identifying, structuring and executing sustainable projects.

Connecting Europe Facility (CEF)

The Connecting Europe Facility (CEF) is a key EU funding instrument to promote growth, jobs and competitiveness through targeted infrastructure investment at European level. It supports the development of high performing, sustainable and efficiently interconnected trans-European networks in the fields of transport, energy and digital services. CEF investments fill the missing links in Europe's energy, transport and digital backbone.

In addition to grants, the CEF offers financial support to projects through innovative financial instruments such as guarantees and project bonds. These instruments create significant leverage in their use of EU budget and act as a catalyst to attract further funding from the private sector and other public sector actors.

2021-2027 Horizon Programme

Based on the Commission Proposal for Horizon Europe, the common understanding between colegislators and the Partial General Approach, both approved in April 2019.

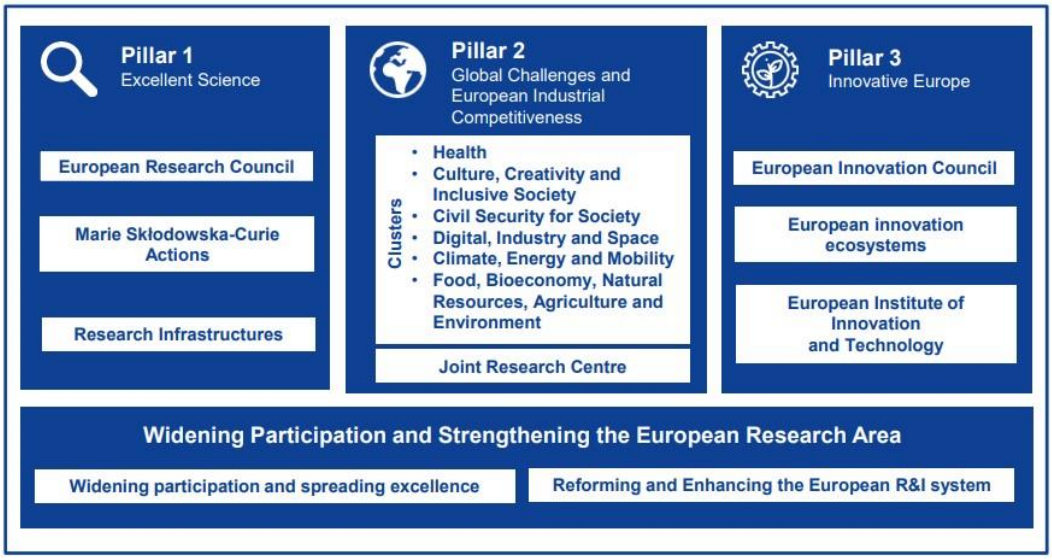

Figure 9. Horizon Europe structure

For the 2021-2027 programmation, the budget has reached €1 824.3 billion, of which:

- 1 074.3 billion (2018 prices) for the Multiannual financial framework;
- 750 billion for Next Generation EU, the recovery plan for the COVID-19 pandemic.

In comparison, the budget of the previous Multiannual Framework (2014-2020) was €908.4 billion. The EU's stated ambition is to target and strengthen certain European flagship programmes to contain the consequences of the health and economic crisis.

FZOEU- National Environmental Protection and Energy Efficiency Fund

The Fund was established in 2003 as a non-budgetary institution. Financing is secured through environmental charges and is allocated to legal and natural persons through loans, subsidies, financial aid, and grants.

The main activities covered by the Fund are financing of preparation, development and implementation of programmes, projects and similar undertakings in the fields of environmental protection, waste management and energy efficiency and use of renewable energy sources.

Consistency with environmental sustainability and energy efficiency policies

The proposed interventions and measures are consistent with the strategies and objectives defined by the energy and environmental planning documents drawn up at regional, national and community level.

- Paris Agreement (Agreement on taking urgent actions to fight climate change and its impacts.)
- IMO 2020 Sulphur Regulation
- Barcelona Convention for the protection of the Mediterranean
- EU 2030 climate and energy framework
- Sustainable and Smart Mobility Strategy – putting European transport on track for the future
- Clean Power for Transport: A European alternative fuels strategy
- DIRECTIVE (EU) 2018/2001 on the promotion of the use of energy from renewable sources
    - DIRECTIVE 2012/27/EU on energy efficiency

Conclusion

Largest part of the emissions is attributed to the large cruise ships as Dubrovnik is mainly cruising destination. That is why landline electricity connection (land to ship) for the docked cruisers is one of the priorities when we talk about lowering emissions.

The commitment of the Dubrovnik Port Authority is to make this port truly sustainable and in the end the flagship of “Green ports”. In that manner, DPA has launched and already prepared several projects aiming to lower their carbon footprint.